PATENT SPECIFICATION

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(54) PRODUCTION OF FRICTION MATERIALS

(71) We, ABEX CORPORATION, a corporation organised and existing under the laws of the State of Delaware, United States of America, of 530 Fifth Avenue, New York 10036, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the production of friction elements such as railway brake shoes, automotive brake linings and the like.

In Griffith United States Patent No. 3,492,262 there is disclosed a composition of matter for producing low friction railroad brake shoes, characterized by cast iron particles 12—30 percent by weight, graphite particles 20—55 percent by weight, asbestos fibres 8—17 percent by weight, phenol formaldehyde thermosetting bonding resin 14—24 percent by weight and up to 30 percent by weight of miscellaneous friction modifiers such as barytes, alumina, coke and so on. The relatively high amount of asbestos fibres disclosed in the Griffith patent is in part responsible for the low friction characteristics, and it may be mentioned that a relatively high amount of asbestos fibres is also characteristic of automotive brake linings.

A conventional compression moulding technique is disclosed in the aforesaid Griffith patent in that, after a homogeneous mixture of the ingredients has been attained, a mould or die cavity may be filled therewith and subjected to a preliminary cure for several hours at high temperature and under a significant amount of pressure. This procedure is responsible for both densifying the mixture and partially curing the thermosetting resin. Afterwards the partially cured, moulded product is then subjected to a final cure involving a prolonged heat cycle of 350°F. or upwards for 10 hours or more.

In Gilbert United States Patent No. 3,334,163, it is disclosed that high costs of producing friction elements by compression moulding involving the simultaneous application of high pressure and high temperature could be avoided by stamping an essentially solvent free mixture which is to say that by first stamping the mixture to its final density at room temperature, thermal cure of the resin may be subsequently accomplished outside the mould without resort to the simultaneous application of high pressure.

This objective can be realized under limited conditions, but experience reveals that when the asbestos content exceeds about five per cent by weight the dry mixture unfortunately tends to delaminate when removed from the mould and subjected to the high temperature cure necessary to advance the thermosetting resin to its completely heat hardened state.

We have now found that dry friction mixtures, devoid of solvent, may be stamped to final density at room temperature, and then cured outside the mould, without the application of pressure, provided with the mixture containing the asbestos is first compressed with a steady amount of low pressure for a time period sufficient to expel the trapped air, and the pressure thereafter being gradually raised to the value determined as that characterizing the final density.

Accordingly, in accordance with the present invention, we provide a method of producing friction elements composed of fillers including five per cent or more by weight of asbestos fibres bonded by a thermosetting resin and comprising: incorporating the mixture of fillers and resin in a die cavity conforming to the geometry of the friction element; applying in a first stage a predetermined initial pressure to the mixture at a substantially constant magnitude which is a proper fraction of the final pressure and for a time sufficient to expel substantially all the air trapped in the mixture; thereafter during a second stage, increasing the applied pressure from said constant initial pressure to a final magnitude determined as that producing the desired density for the mixture; and stripping the pressed element from the die cavity and subjecting it to a time tem-

perature curing cycle to cure the thermosetting resin.

We have found that in the practice of preferred methods within this general scope, we have been able to avoid delamination whilst retaining what is regarded in the art as a relatively high amount of asbestos.

The invention is hereinafter more particularly described by way of example only with reference to the accompanying drawings in which:—

Figure 1 is a sectional and somewhat schematic view of a press suitable for use in a method in accordance with the present invention;

Figure 2 is a part sectional view of a railway brake shoe, such as may be produced by a method in accordance with the present invention; and

Figure 3 is a graph illustrating the pressure cycle used in a preferred method in accordance with the present invention.

Constituency and proportioning of the mixture to be stamped will vary dependent upon whether the resultant friction element is in the form of an automotive brake lining, a railway brake shoe, clutch disc and so on. Thus the friction and wear characteristics, depending upon use, may vary widely, and are determined by adjustment or variation in the components constituting the mixture being pressed. In any event, the present invention will be practiced in terms of an asbestos content of five per cent or more by weight. There follows a specific example relating to the manufacture of a railway brake shoe by one method in accordance with the present invention:

Example 1

Component	Range (% by Weight)	Most Preferred (% by Weight)
Phenol formaldehyde resin (Novolak)	14—24	24
Particles of cast iron (+120 mesh)	12—30	17.5
Graphite particles (−60, +325 mesh)	20—55	21
Asbestos fibres (Grade 4K)	8—17	8.5
Friction modifiers (barytes or alumina, 95% −325 mesh; coke, −20 mesh)	0—30	29

The Novolak is heat settable (cure by hexamethylene tetramine, herein "hexa") to a thermosetting state. The dry ingredients of Example 1 are blended homogeneously, and a measured amount thereof, 10, Fig. 1, is placed on top of a steel back 12, the latter being complementally related to a fixture 13 in the forming mould or die 15. A heat activatible bond may be applied to the adjacent face of the back 12 as an air to bonding the friction mixture 10 thereto, although for the most part the interlock between the friction mixture 10 and the back 12 is by means of openings 12A in the back into which the mixture is forced by extrusion during the stamping operation.

After the measured amount of the friction mixture has been thus juxtaposed on the back 12 supported in the die cavity, the punch or plunger 20 is presented, compressing the dry mixture 10, and this operation is conducted in accordance with the curve ABC of Fig. 3 which applies to the preferred mixture specified in Example 1. Thus the initial pressure of the plunger in a first stage, consolidating the mixture at room temperature, exerts a pressure of about one ton per square inch (line AB, Fig. 3) for about 20 seconds, which is a proper fraction of the final pressure, and then the pressure is raised from the initial magnitude along the gradual slope BC of Fig. 3 to a final magnitude of about 12 tons per square inch over a period of about 50 seconds, compressing the mixture to its final density which is about 90 percent of theoretical density. Preferably, but not essentially, the pressure of 12 tons per square inch may be applied as a steady value for about 15 additional seconds, indicated by the dotted line in Fig. 3.

The die plunger is then retracted, and the united assembly, Fig. 2, is removed from the die cavity in the form of a railway brake shoe 30 including the back 12 and the densified friction block 10A. It will be appreciated that what is shown in Fig. 2 is not a limiting factor in terms of geometry.

The consolidated assembly, Fig. 2, is then transferred to a heat treating furnace where it is baked for about ten hours during which time the temperature is raised from about 150°C to about 230°C. The upper temperature is then maintained for about six additional hours, resulting in a complete cure of the phenol formaldehyde resin binder. The phenolic binder of Example 1 is a novolak, containing about six percent of an accelerator such as "hexa" to hasten the cure. However, a one-step heat hardenable phenol formaldehyde resin may be used as well, or in combination with a novolak. In some instances the binder may include an oil modified phenol formaldehyde resin, or other modifiers such as vulcanizable Buna-N rubber or the heat hardenable polymer of cashew nut shell oil.

In any event, the major and essential constituent of the binder is a heat hardenable phenol formaldehyde resin known *per se*, as heretofore used in the manufacture of friction elements.

Regardless of the precise formula for the dry mix being stamped, and regardless of whether Example 1 is modified to fit the needs for an automotive brake lining, by a large amount of asbestos, up to 50 or 60 percent by weight, and different forms of friction and wear particles, the order of applied pressure will conform generally to the curve ABC, Fig. 3, in that there will always be an initial holding period along a steady line such as AB, followed by a pressure increase along a slope such as BC, although for a friction composition varied from that of Example 1 the line of steady initial pressure AB may commence at an ordinate magnitude somewhat more or less than the value depicted in Fig. 3 depending upon the asbestos content, which is largely responsible for trapping air, and point B may be extended more or less along the time (abscissa) axis, again in direct proportion to the asbestos content. In other words, as the density of the mixture decreases (e.g. more asbestos fibers trapping more air) the parameters of the line AB will be greater in terms of greater applied pressure or of a longer time, or both.

The gradient of slope BC of the curve ABC really depends upon the capacity of the press represented by the die and plunger, Fig. 1, which is to say that the change in pressure (dP) per unit of time (dt) along the slope BC may be a straight line function or an exponential function; it makes no difference, because the ideal circumstances is to attain final pressure as quickly as possible within cost limitation.

Hence while a preferred method in accordance with the invention has been illustrated and described, it is to be understood that this is capable of variation and modification in producing other kinds of friction elements.

WHAT WE CLAIM IS:—

1. A method of producing friction elements composed of fillers including five per cent or more by weight of asbestos fibres bonded by a thermosetting resin and comprising: incorporating the mixture of fillers and resin in a die cavity conforming to the geometry of the friction element; applying in a first stage a predetermined initial pressure to the mixture at a substantially constant magnitude which is a proper fraction of the final pressure and for a time sufficient to expel substantially all the air trapped in the mixture; thereafter during a second stage, increasing the applied pressure from said constant initial pressure to a final magnitude determined as that producing the desired density for the mixture; and stripping the pressed element from the die cavity and subjecting it to a time-temperature curing cycle to cure the thermosetting resin.

2. A method according to Claim 1, wherein pressure is applied in said first and second stages in accordance with the curve ABC of Fig. 3 of the accompanying drawing.

3. A method of producing friction elements composed of fillers including five per cent or more by weight of asbestos fibres bonded by a thermosetting resin, which method is substantially as hereinbefore described with reference to the accompanying drawing.

4. A friction element whenever produced by a method according to any preceding claim.

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1350268 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

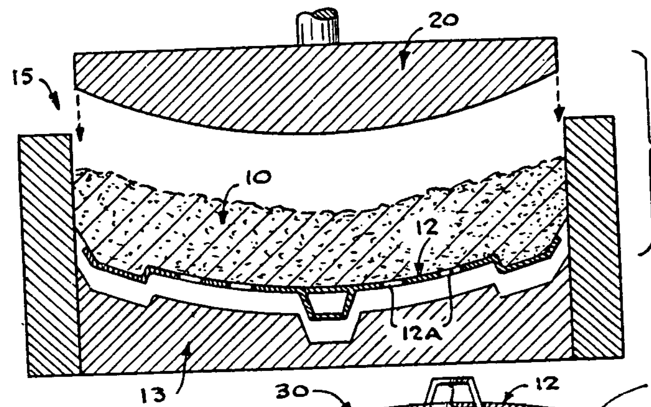

Fig.1

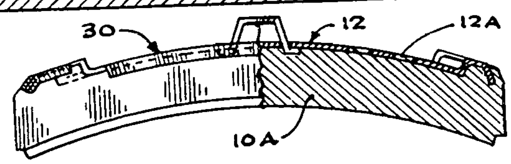

Fig.2

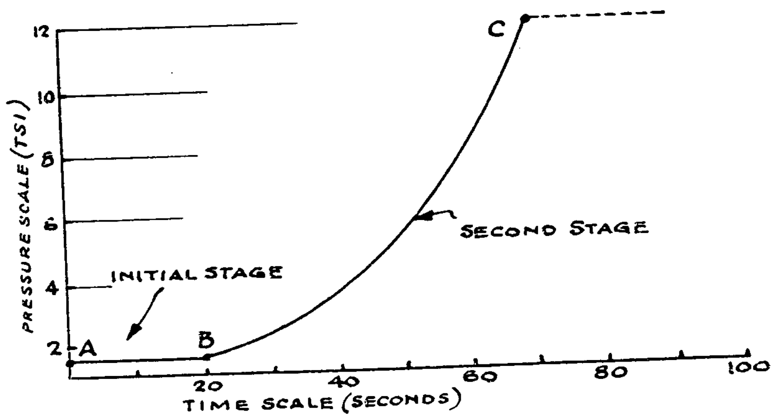

Fig.3